# GIS Duplication Analysis and Recommendations for Vermont State Government

## (As Directed by Act 63 Sec. E. §122(a) in 2011)

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Acronyms Used In This Document

ACCD – Vermont Agency of Commerce and Community Development

AHS - Agency of Human Services

ANR – Vermont Agency of Natural Resources

BGS – Vermont Department of Buildings and General Services

DII – Vermont Department of Information and Innovation

E911 – Vermont Enhanced 911 Board

CIO – Chief Information Officer

GIS – Geographic Information Systems

GIT – Geographic Information Technology

GPS – Geospatial Positioning System

EGC – Vermont Enterprise GIS Consortium

ELA – Enterprise License Agreement

RPC – Vermont Regional Planning Commissions

VCGI – Vermont Center for Geographic Information

VEM – Vermont Emergency Management

VTrans – Vermont Agency of Transportation

# Executive Summary

Act 63, Sec. E. §122(a) of the 2011 Vermont legislative session directed "The Vermont Center for Geographic Information Inc., in consultation with the department of taxes, the agency of natural resources, and the agency of transportation, shall report to the House and Senate Committees on Government Operations and on Appropriations on or before January 15, 2012, on methods to reduce and prevent duplication of services and activities across state government with regard to mapping services and other geographic data resources".

Vermont state government has reason to be proud of its long recognition of the value of Geographic Information Systems (GIS) and the data, infrastructure, and resources that have been developed in support of the state's GIS capacity over the years. As a result of this long tradition of support, the state has established an environment of GIS resource management and access that has provided economic and operational benefits. Today, GIS related resources are created, maintained and distributed by several agencies in the state.

The recommendations in this report support the creation of a broadly defined Federated Enterprise GIS solution as well as bolstering foundation level statewide GIS data products and services. The establishment of statewide basemap products within a robust data distribution framework will provide meaningful customer service benefits to both agency staff and the public alike. Bolstering support for foundation datasets such as parcels and imagery, two foundation basemap products used by state government and the public, reduces duplication by harmonizing efforts between state agencies. A Federated Enterprise GIS will streamline access to GIS data and services while at the same time reducing unnecessary duplication.

As stakeholders in the Federated Enterprise GIS, agencies in the state that have GIS capacity must be active in the governance of the enterprise through the state's Enterprise GIS Consortium (EGC). Created in 2008, "the EGC is a voluntary consortium of state government organizations focused on effective management of State's Enterprise Geographic Information System (GIS)"[1][2].

## *Summary of Recommendations*

Management and Governance Recommendations

- Direct all state agencies using GIS to actively participate in the state's Enterprise GIS Consortium (EGC).

- Task the EGC to provide governance for the state's Federated Enterprise GIS.

- Task the Vermont Center for Geographic Information to act as the operational manager of the state's Federated Enterprise GIS solution.

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[1] VT Enterprise GIS Annual Report - 2011
[2] VT Enterprise GIS Consortium Charter, 2008

- Direct the EGC to develop a sustainable business case for a Federated Enterprise GIS, including a documented Cost-Benefit Analysis, to ensure dollars are spent in the most efficient manner possible.

GIS Hardware/Software Recommendations

- Support the implementation of the EGC's Federated Enterprise GIS strategy (including shared servers) to ensure the highest return on investment and efficient use of GIS resources.

- Provide adequate funding to establish and maintain the infrastructure and personnel resources necessary for a robust Federated Enterprise GIS environment.

- Evaluate the potential benefits of an Enterprise License Agreement with ESRI (the leading GIS software vendor in Vermont) through BGS with support from VCGI and the EGC.

GIS Data and Services Recommendations

- Provide legislative mechanisms and funding to support a statewide parcel mapping effort with partnerships between VCGI, Vermont Tax Department, RPCs and the Towns.

- Continue state support for the statewide orthophotographic imagery program to ensure this shared resource is kept current and maintained as a consistent basemap for state and town GIS activities.

- Support a coordinated statewide data creation strategy that allows for cross agency uses, increases the number of authoritative data providers, and improves data access.

- Enable the creation of a robust data distribution system that supports multiple ways to access GIS data including mobile solutions.

- Support VCGI's "core mission"; basemap data products and services, robust data distribution framework, and assistance with technical issues, standards and guidelines.

It is important to recognize the implementation of these recommendations will improve data sharing and reduce duplication of GIS resources. Geographic Information Systems act as information value multipliers because of their ability to integrate, synthesize, and visualize information. The development of GIS resources has proven to provide a high return on investment as shown repeatedly in state[3] and regional studies. Enterprise GIS implementations in California, Florida, Nebraska, South Carolina and Colorado have documented similar significant savings and/or revenue increase opportunities for local and regional governments.[4]

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[3] Compiling a Business Case for a State GIS Clearinghouse, Danielle Ayan, Georgia Institute of Technology, Center for Geographic Information, ESRI User Conference 2003
[4] Building a Successful Enterprise GIS strategy: An ROI approach, Presentation by Micheal Funaro - ESRI

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**The efficiencies discussed in this report will only be realized if the state allocates sufficient funding to establish and maintain a Federated Enterprise GIS environment with a robust hardware/software infrastructure, adequate personnel resources, and strong governance.**

# Introduction

Geographic Information Systems (GIS) are generally defined as a system of hardware, software and personnel that create, manage, analyze, and display geographically referenced information. GIS is a critical tool for many agencies within state government, and it is this broad applicability of GIS that provides opportunities for sharing data and resources.

In response to the direction provided in Act 63 Sec. E. §122(a), the Vermont Center for Geographic Information (VCGI) has reviewed the current state of mapping services and other geographic data resources throughout state government. VCGI undertook this effort with help from state GIS professionals and production personnel from the Department of Taxes, Agency of Natural Resources (ANR) and Agency of Transportation (VTrans) as directed. The Vermont Enterprise GIS Consortium (EGC) has endorsed the vision presented in this report.

# Approach

VCGI compiled information for this report from numerous in-state and out-of-state resources. There were discussions with Vermont agency GIS personnel about their use of GIS technology as well as the data and services they provide. The EGC was consulted and participated in a review of this report with contributions and recommendations from some of the members. There were information requests made to state GIS coordinators in other states through the National States Geographic Information Council in regard to their experiences in establishing an Enterprise GIS in their state. Documentation from other states[5] [6] [7] and the private sector [8]regarding GIS consolidation and enterprise best practices were consulted.

# Background

Vermont recognized the value and importance of GIS relatively early in its evolution when the Vermont General Assembly designated in statute VCGI's charge to develop and implement "a *comprehensive strategy* for the development and use of a Vermont geographic information system…"[9]. Vermont's foresight in establishing this commitment has paid off substantially in several ways;

- Valuable data was created, shared or archived that otherwise would have been unavailable or, if created, subsequently gone unmaintained,

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[5] Geographic Information System (GIS) Study, North Carolina Office of State Budget and Management, February 2008
[6] Oklahoma State Department of Health Geographic Information Systems (GIS) Needs Assessment and Requirements Analysis, Oklahoma State Department of Health, Katy Rich, July 2008
[7] Oregon Geospatial Coordination Model, Oregon Geospatial Information Council
[8] The Evolution to Enterprise GIS, ESRI ArcNews, Winter 2007/2008
[9] VT Statutes 1994, Act 204 10 VSA §122

- Data sharing and responsible data creation practices were established early thereby reducing data duplication and potential misuse,

- Geographic information resources were made available for the state's planning, resource management, and economic development efforts,

- The VT GIS community grew to recognize the value of relying upon robust and authoritative data providers, thereby reducing redundancy, program costs, and improving services.

# Current GIS Infrastructure in Vermont State Government

There are three recognized and distinct functional areas of any standard GIS architecture.

- Data

- Hardware/Software

- Personnel

These three functional areas represent the fundamental architecture of any information technology (IT) environment, and the State's geographic information technology (GIT) environment is no different in its composition. This report uses these three architectural components as the foundation for our recommendations to reduce duplication of GIS activities.

## *Data – Current Practices*

The term data as used in this report will refer primarily to geographic data, both vector (roads, rivers, buildings, etc.) and raster (orthophotography, elevation models, etc.).

State agencies currently collect and manage a wide range of geographic data. Data is shared through a voluntary data exchange agreement called the "Geospatial Data Exchange Protocol" created through the EGC. The protocol defines "a robust set of standards and methods for sharing and replicating data across agencies and departments"[10]. This protocol allows EGC members to participate as data 'Publisher', 'Subscriber', or both. In addition, the EGC has established Data Management Standards and ArcSDE® Configuration and Management Guidelines[11] to ensure consistency and predictability. GIS data is shared with the public via the VGIS Data Warehouse[12]; a data portal which provides access to the State's GIS data resources.

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[10] VT EGC Geospatial Data Exchange Protocol (available www.vcgi.org/EGC)

[11] EGIS Data Management Standards and Procedures ; ArcSDE Configuration and Management Guidelines (available www.vcgi.org/EGC)

[12] http://www.vcgi.org/dataware/

Table 1 below shows the level of Data Warehouse participation by agency.

| Activity | VCGI | VTrans | ANR/ ACCD | VEM/ DPS | E911 | AHS/ VDH | AGR | RPCs |
|---|---|---|---|---|---|---|---|---|
| Geospatial Data Exchange Protocol - Publisher | x | x | x | | | | | |
| Geospatial Data Exchange Protocol - Subscriber | x | x | x | x | x | x | x | |
| Share data via VGIS Data Warehouse | x | x | x | | x | | | x |
| Implemented ArcSDE Configuration and Management Guidelines | x | x | x | | | | | |
| EGC member | x | x | x | x | x | x | x | x[13] |

**Table 1**

Other GIS data users in the state include the Agency of Agriculture Food and Markets (AGR), the Department of Public Service (DPS), the Department of Information and Innovation (DII), the Department of Education (DOE), and the Department of Buildings and General Services (BGS). AGR is restarting a GIS capacity that was dormant for a few years. DPS is currently upgrading its GIS environment. For the most part GIS usage in DPS, DII, and DOE is either only occasional or it is currently managed or performed by a single individual. GIS capacity in those organizations is very limited.

## Basemap Data

Basemap data is commonly referred to as foundation data and it represents data that should be universally shared across agencies. At a minimum they represent layers needed by all GIS users within state government. Table 2 below lists layers often considered to be part of any basemap.

| Data Type | Data Manager |
|---|---|
| Digital Orthophotography, Elevation (topography) | VCGI |
| Roads, Geodetic Control | VTrans |
| Hydrography (rivers and lakes), public lands | ANR |
| Buildings (addresses) | E911 |
| Parcels | Municipalities/RPCs |

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[13] VT Regional Planning Commissions are represented by a VAPDA in the EGC

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| Political units (state, county, town, village boundaries) | VCGI |
|---|---|

<div align="center">**Table 2**</div>

## Program Data

Program data is created, maintained and used by agencies for specific operational needs. Most agency operational data is shared between state agencies and available to the public. In a few cases there are privacy or security concerns preventing wider access to these datasets. There is little duplication occurring with program or operational data.

## *Hardware/Software – Current Practices*

A wide range of hardware is used to support GIS activities within state government. This report will focus on GIS server hardware. Workstations and PCs (personal computers) are dedicated to the business and operational needs of individual agencies, and therefore are beyond the scope of this report.

The leading supplier of GIS software in the state is ESRI[14]. The state Department of Buildings and General Services recently completed a Master Purchase Agreement (MPA) enabling universal pricing and purchasing for ESRI products. Additional software providers are used by agencies for specialized application development or online mapping capabilities.

In 2008, VCGI and the EGC negotiated an Enterprise software license agreement with Latitude Geographics for their Geocortex IMF web development platform. This agreement is currently being renegotiated between the EGC and Latitude Geographics as the stakeholders upgrade the Geocortex web mapping platform.

Vermont state agencies with server-based solutions are using ESRI's ArcGIS Server® product. In addition, some agencies also use a product from ESRI called ArcSDE® (ArcGIS Spatial Database Engine) to optimize data storage, maintenance, and access. Current GIS hardware and software practices at state agencies are shown in Table 3 below.

| Current Practice | VCGI | VTrans | ANR/ ACCD | VEM/ DPS | E911 | AHS/ VDH | AGR |
|---|---|---|---|---|---|---|---|
| Manage a dedicated GIS Server | x | x | x | x | x | x | |
| Geocortex IMF Partner | x | x | x | | | | |
| ESRI ArcGIS Server deployment | x | x | x | x | | x | |
| ESRI ArcSDE deployment | x | x | x | x | x | x | |
| ESRI ArcGIS Desktop deployments | x | x | x | x | x | x | x |

<div align="center">**Table 3**</div>

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[14] Environmental Systems Research Institute

Figure 1 below represents the current physical GIS server infrastructure by agency.
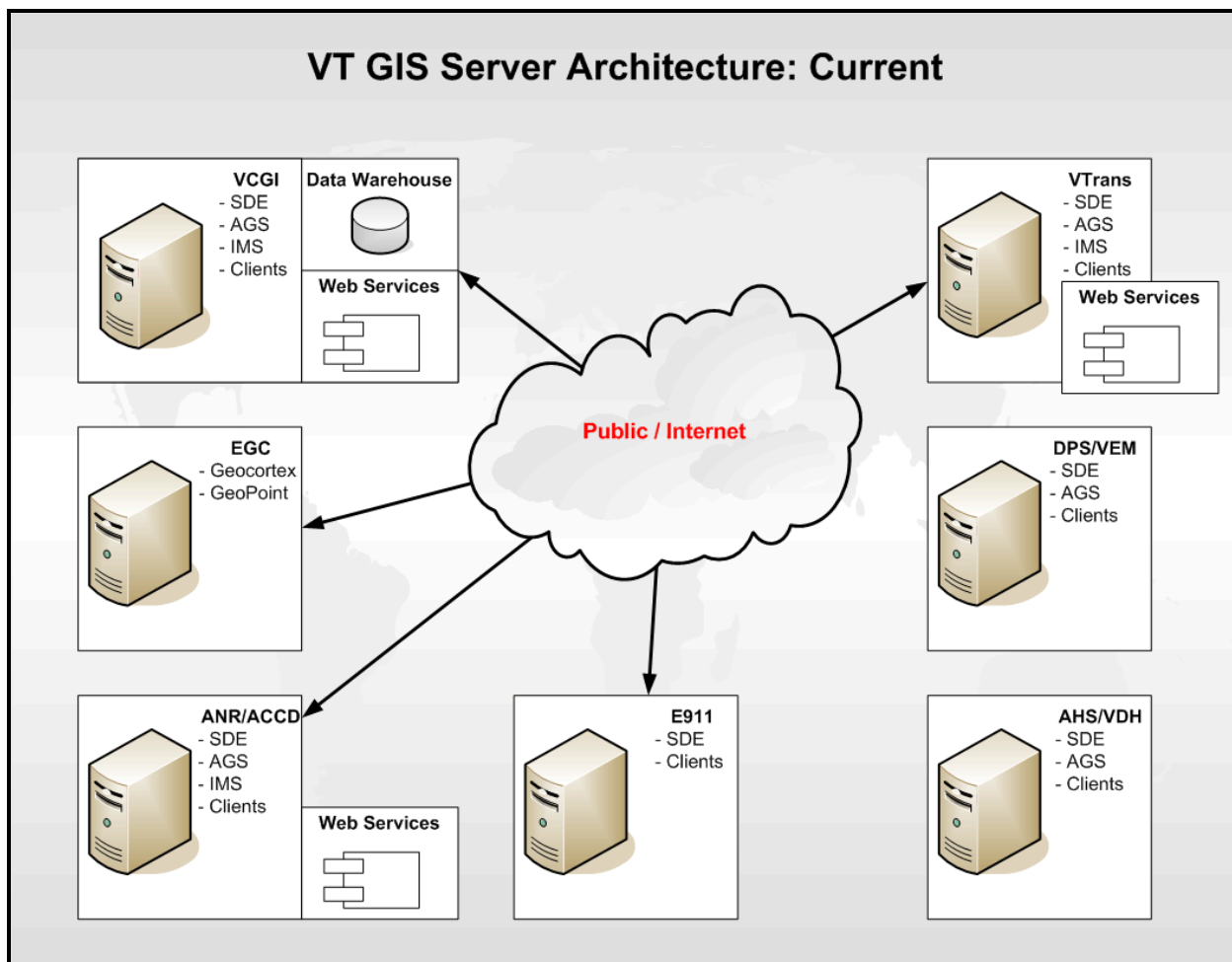


**Figure 1.**

ANR and ACCD currently share one GIS server including server level software. The Department of Health (VDH) and the Agency of Human Services (AHS) also share one GIS server including server level software. DII currently houses and maintains a server for the EGC that provides the aforementioned Geocortex web development platform as a service for those agencies that partnered in the agreement.

## Personnel – Current Practices

Dedicated GIS staff levels in the agencies and departments across the state have grown to support specific business requirements. There are dedicated GIS personnel at VCGI, VTrans, ANR, and the Health Department.  VEM and the Department of Public Safety contract with VCGI and the Regional Planning Commissions for personnel to provide GIS support.  Their information technology staff contributes to the maintenance of their hardware and software.

There is no recognized duplication of GIS personnel in VT state agencies. In fact, there are instances where more personnel or personnel time is needed beyond what is currently available. Available funding is at the core of this problem, and it cannot be improved without agencies getting new funding sources or redirecting funding from other areas.

# Duplication of GIS Activities

There is no evidence of extensive duplication of GIS data, services, and/or personnel in Vermont state government. A well-established coordination environment and a culture of communication and sharing have reduced duplication beyond what is necessary to support specific agency business requirements. However, VCGI and the EGC have identified opportunities to minimize redundancy and improve services. Table 4 below outlines several of these opportunities.

## *Data - Opportunities*

| Data Product Type | Recommendation | Value |
|---|---|---|
| ***Basemap Data*** | Continue orthophotographic imagery acquisition. | Efficiencies in agency operations, cost savings, critical product used for mapping operational data. |
| | Cached imagery by year. | Identify land use and land cover changes, enforcement issues, stream and river alterations. |
| | Collect elevation data – LiDAR. | Hazard mitigation such as flood analysis, increased agency planning and engineering capacity. |
| | Statewide parcels . | Used by several agencies to help administer Use Value Appraisal, storm water management, forest stewardship, permitting, transportation and environmental enforcement. Greater customer service support. |
| | Support E911 –VTrans Road Centerline consolidation. | Robust, common road data resource for state. |
| ***Data Discovery and Access*** | Increase discoverability and access to agency program data. | Reduced data duplication, increased program efficiencies, Improved customer service and transparency. |
| | Update and improve data warehouse and distribution systems. | Improved data discovery and access options, customer service and transparency. |
| | Support agency branding. | Recognition of agency products, programs and services. |
| | Increase data format options. | Increased flexibility for agency services and public customer service, provision of map products for mobile environment. |
| | Encourage Regional Planning Commission's further participation and use of data warehouse and | RPCs can perform role of regional data center, use RPC GIS expertise and capacity to support state and |

| | | |
|---|---|---|
| | distribution systems. | local policymakers in making better informed decisions[15], RPCs participation is critical for statewide parcel mapping effort. |
| | Encourage Regional Planning Commissions' use of the Geospatial data exchange protocols. | Increased participation in data sharing relationship for RPCs in role as regional data center. |
| | Expand and enhance web services including a basemap, image cache, and geodata services. | Increased flexibility for agency services and public customer service. |
| GIS Data Services | Support VCGI's "core mission" focus: data and data services. | Efficiencies in agency operations, development of redundant data and data services. |

**Table 4**

## *Hardware/Software - Opportunities*

| Hardware/Software | Recommendation | Value |
|---|---|---|
| GIS Servers | Deploy shared GIS servers (production/development) and services to support the Federated Enterprise GIS environment. | Reusable services and capabilities available to all, reduced redundancy, increased efficiencies, shared resources, more robust server environment. |
| | Charge VCGI with day-to-day management of the shared Enterprise GIS servers and services. | Consistent day-to-day operational management. |
| | Charge the EGC with governance for the Federated Enterprise and shared GIS servers. | Leverage an established governance structure that supports multi-agency collaboration and consensus. |
| | Support agencies with limited GIS capacity by establishing shared GIS servers and services. | Expand access to GIS resources at a lower cost to those agencies looking to expand their use of GIS. |
| | Pursue Enterprise License Agreement with ESRI. | Potentially reduced software costs, increased access to GIS Enterprise support tools. |
| GIS Clients | Develop robust web-based GIS solutions. | Reduce number of ArcGIS client licenses, lower cost, off-site access to GIS resources. |
| Mobile Clients | Create infrastructure and services to support mobile device applications. | Off-site access to GIS resources, increased customer service. |

**Table 5**

Agencies and departments involved in public safety have business needs that demand they ensure the privacy and safety of the public. However, within the public safety business area departments should be developing a unified GIS server and data storage environment. A unified

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[15] Executive Report for VAPDA Statewide Assessment from the National Association of Development Associations, June 2011, Major Recommendations

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environment will reduce the deployment of independent GIS servers and data repositories within VEM and Public Safety. It will also simplify data access and control issues inherent in any public safety environment. Public Safety has made an effort to establish a unified server environment for other digital resources.

As funding allows, VEM or the Department of Public Safety should hire a full-time GIS professional that would be dedicated to GIS data management and system support for both VEM and the Department of Public Safety. Until the time when a dedicated GIS data and systems manager is added to the staff, VCGI and the RPC's can continue to provide contracted GIS support. VEM and the Department of Public Safety should continue to provide representation to the EGC.

Figure 2 below graphically represents the recommended Federated Enterprise GIS configuration designed to reduce redundancy and improve data sharing. The vision outlined in Figure 2 assumes sufficient resources are allocated toward the design, deployment, and ongoing management of shared GIS servers and services as outlined in the diagram.
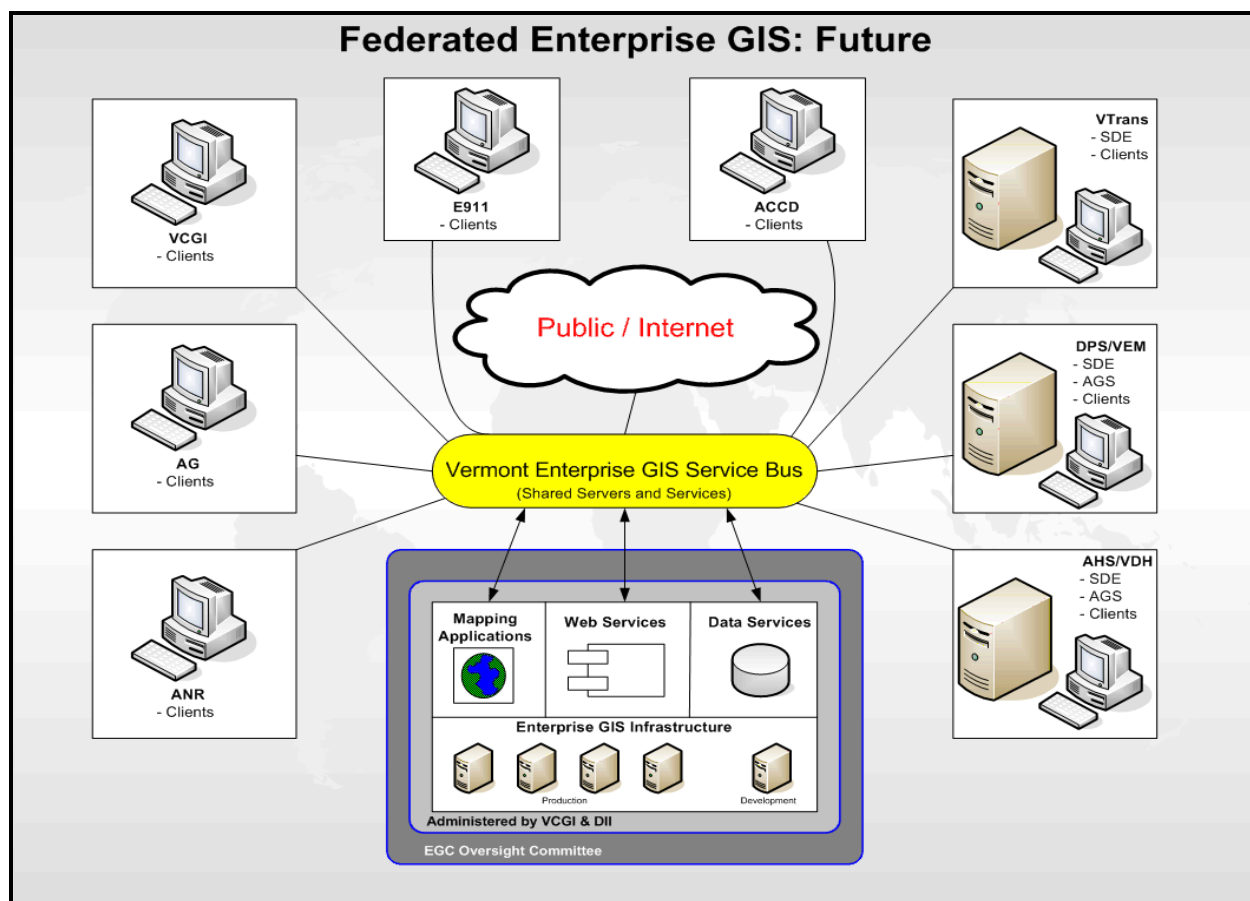


**Figure 2**

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The recommended Federated Enterprise GIS environment will include;

- A centralized set of shared servers and services administered by VCGI with oversight by the EGC,

- An Enterprise GIS Service Bus consisting of common EGC standards and protocols designed to facilitate data sharing and access,

- A Federated strategy allowing agencies to deploy agency level solutions to meet their specific business needs.

For this approach to be successful, all agencies using GIS must be active members of the EGC. Each agency will have a defined role in providing agency specific authoritative data and services to all of the other agencies within the Federated Enterprise, thereby eliminating the tendency for duplication. Roles and responsibilities for each agency will be defined and documented. Agencies will be able to share and access data according to the standards and protocols established by the EGC.

## Management and Governance of the Federated Enterprise GIS

The shared GIS servers and services outlined in Figure 2 will need to be effectively managed by a designated organization. We believe this shared environment should be managed by VCGI. The hardware should be hosted by DII in DII's central server facility if it is found to be cost effective and meet the needs of the Enterprise. The EGC should also consider how third-party cloud solutions might fit into the mix. A full evaluation of the best hosting solutions should be performed to identify the most cost effective and operationally robust approach. VCGI should also be responsible for managing the VT GIS Data Warehouse and public data access portal as part of the Federated Enterprise GIS environment. VCGI already plays a central organizational role in managing the state's geographic data repository (VT GIS Data Warehouse), distributing data and coordinating data efforts in the state as required in VCGI's enabling statutory language.

However, VCGI should act only as manager of the shared GIS server environment, a component of the Federated Enterprise GIS defined in Figure 2. Governance of the Federated Enterprise GIS should be the responsibility of the EGC. The EGC should establish the operational protocols, the rules of participation, and the responsibilities of all participants in the Federated Enterprise GIS environment.

Establishing the EGC as the body with responsibility for governance of the Federated Enterprise GIS environment enables each participating agency to have an active role. It also ensures the Enterprise environment will be developed and managed in a manner supporting agency needs.

### *Advantages of the Federated Enterprise GIS Approach*

Implementation of a Federated Enterprise GIS strategy will;

- Reduce duplication of GIS data and services by providing access to shared data and resources to all state agencies,

- Agencies with special business requirements or privacy and security concerns will be able to manage their own GIS servers according to their own business rules while still participating in the Enterprise,

- Enterprise protocols will be standardized according to industry best practices opening data access and data sharing to all participants (as appropriate),

- Agency participation will be formalized through documented agreements ensuring a set of clear and consistent expectations for all participants,

- Technical management for the Enterprise's shared server and services environment will be the responsibility of a single designated organization,

- The EGC will have responsibility for providing governance over the Federated Enterprise GIS environment, giving all agencies a seat at the table.

## Funding

The request by the Legislature to report "…on methods to reduce and prevent duplication of services and activities across state government…" did not provide funding to perform the analysis, therefore VCGI did not have the resources to conduct a detailed business case analysis for the creation of a Federated Enterprise GIS in Vermont.  As a result, we recommend each agency using GIS perform a cost-benefit analysis on GIS in their agency. This effort should be coordinated by the EGC and consideration should be given to having the analysis facilitated by an outside consultant.  The EGC should use the cost-benefit analysis to create a supportable business case for a Federated Enterprise GIS.

Funding to support the creation and management of shared servers and services within the Federated Enterprise GIS environment must be sufficiently adequate to support a robust system. VCGI's existing yearly funding will not cover both the existing responsibilities of the organization and all of the newly added Enterprise support required. VCGI can use some of its existing funding to support the Enterprise, but additional funding will be necessary for the following;

1.) To purchase the necessary hardware and equipment,

2.) To support the yearly maintenance and data storage costs of the purchased hardware,

3.) To support the purchase, installation and maintenance of the necessary GIS server software on the servers,

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4.) To support the labor necessary for configuration and maintenance of the shared servers and enhanced data distribution and web services,

5.) To support the labor necessary to implement the governance recommendations and standards established by the EGC,

6.) To support the coordination and resources necessary to enable statewide parcel mapping,

7.) To support the continuation of the statewide orthophotography program,

8.) To contract with an independent consultant to perform a Cost-Benefit Analysis of different Enterprise GIS approaches.

These efforts will require continuous operational funding support past initial implementation.

## VCGI - In or Out Of State Government?

In the creation of this report more than one agency thought it important to discuss the question of whether VCGI should be subsumed within state government from its current standing as a non-profit instrumentality of the state.

The following are listed as perceived advantages to moving VCGI into State government;

1. Improved acceptance of VCGI's role by other state agencies,
2. Improved inter-organizational fund transfer capabilities,
3. Direct management by an existing agency,
4. Greater access to agency resources,
5. Reduced overhead (benefits management, audit, corporate requirements, etc.),
6. Possible greater ability to access funding resources year to year.

The following are listed as potential disadvantages in moving VCGI into State government;

1. Potential loss of control over organizational mission, potential resource reassignment by parent agency,
2. Change in perception of VCGI's role as independent provider of geospatial resources,
3. Less grants and contracts from outside – more focus on state appropriation funding,
4. Loss of flexibility in personnel hiring and management,
5. Loss of flexibility in benefits management,
6. Loss of financial resource flexibility,
7. Loss of geospatial data and technology coordination outside of state government.

## Summary

This report outlines an achievable Federated Enterprise GIS solution to optimize GIS activities in the state. The report provides recommendations for improving the hardware/software

architecture of the state's GIS activities, and it provides recommendations for improvement of the state's shared basemap data and data services. Recommendations for management and governance of this Federated Enterprise solution leverage existing organizational frameworks. Agencies in the state using GIS may be willing to move forward on implementing a Federated Enterprise GIS solution if the design meets their needs and the cost model is sustainable.

Only by applying the resources necessary to create and maintain the recommended Federated Enterprise GIS solution can the state realize all of the potential benefits. The path to successfully upgrading any technology is inevitably not without its challenges and setbacks. The Federated Enterprise GIS solution recommended in this report can be implemented in phases to reduce risk and spread the cost, but the implementation must be robust and should begin soon. The GIS community is ready and willing to begin the process of improvement.

# Acknowledgements

VCGI would like to mention our appreciation for the contributions of the following individuals, and organizations in providing guidance to the findings and recommendations in this document.

The members of the VT Enterprise GIS Consortium (EGC)

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Vermont State Agency Personnel